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発明の名称　試料吸収電流像の観察法

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明　細　書

発明の名称　試料吸収電流像の観察法

特許請求の範囲

一次電子線を試料表面上において収束および走査させる機能を備えた一次電子線ビームコラムと試料表面上の一次電子線の走査に同期して試料に流入する荷電子流を陰極線管上に輝度表示し、試料吸収電流像を得ることが可能な映像表示装置と、試料表面をイオンビームではく離するためのイオン銃から構成される試料吸収電流像観察装置において、試料表面上収束した一次電子線で走査させ、同時に同試料表面をイオンビームではく離しながら試料吸収電流像を得ることを特徴とする観察法。

発明の詳細な説明

本発明は試料表面をイオンビームではく離しながら試料吸収電流像を得る観察法に関するものである。

最近IC等固体表面の微小部観察の要求に伴ない、電子マイクロプローブ表面分析が注目を集めている。例えば電子マイクロプローブを用いるオージエ電子分析法において試料吸収電流像はオージエ電子分析の点分析の際の場所選定のモニターとして利用され、さらに表面状態に著しく依存することから独自の表面顕微法として用いられる可能性がある。

固体表面に電子線（一次電子線）を照射したとき、同固体表面から別の電子（二次電子）が放出される二次電子放出という現象がある。一次電子流I_1と一次電子線が弾性あるいは非弾性散乱過程を経て固体表面から放出する電子と二次電子と合わせた電子流I_2との比（I_2/I_1）をδとする。δは固体表面の元素、幾何学的形状、表面の結晶構造等表面状態に著しく依存する。従つて固体試料表面上の一次電子線の走査に同期して同試料に流入する電子流を陰極線管上に輝度表示することにより、一次電子線の固体表面走査領域のδの差異による試料吸収電流像を得ることができる。

また固体試料表面にイオンビームを照射することにより同試料表面の原子がたたき出され、同試

料表面をはく離するイオンエッチング（ion etching）法が固体表面の清浄化、界面分析等の手段の一つとして固体表面技術の分野で広く利用されている。

本発明は一次電子線の試料表面上の走査と同時に同試料表面にイオンビームを照射し、同試料表面のはく離による表面状態を試料吸収電流像によつて動的観察が可能であることを特徴とする。

以下実施例にもとづいて発明の詳細について説明する。

図は本発明の実施例の一つで、一次電子ビームコラム、イオン銃の構成と試料吸収電流像の記録系を示す説明図である。第1図で1は一次電子線源、2は一次電子線収束用のウエーネルト電極、3、4は一次電子線収束用磁界レンズ、5は一次電子線を試料表面上で一方向に走査する偏向コイル、6は一次電子線を試料表面上で5のコイルによる走査方向と垂直方向に走査する偏向コイル、7は一次電子線の方向を示す線、8は試料、9はイオン銃、10はイオンビームの方向を示す線、11は試料に流入する荷電子流のうちδの差異を反映する電流（I_1-I_2）を陰極線管の輝度変調信号と変換する電気回路、12は陰極線管を示す。

イオン銃9から発生した直流イオンビームは一次電子線の固体試料走査領域を照射し、同試料表面をはく離する。従つて同試料に流入する荷電子流は一定のイオン電流と一次電子線の走査領域のδの差異を反映する電子流（I_1-I_2）の和である。電気回路11により試料に流入する荷電子流の直流成分をカットし変動分を固体表面上の一次電子線の走査に同期して陰極線管12の輝度変調信号に変換することにより試料吸収電流像を得ることができる。同条件から得られる試料吸収電流像において、イオンビームの径を一次電子線走査領域に比べて小さく設定すれば、はく離の進んでいない部分と進んでいる部分の表面状態の動的観察ができる。逆にイオンビームの径を一次電子線走査領域に比べ充分大きく設定すれば、固体表面からの一定の深さにおける表面状態の動的観察ができる。

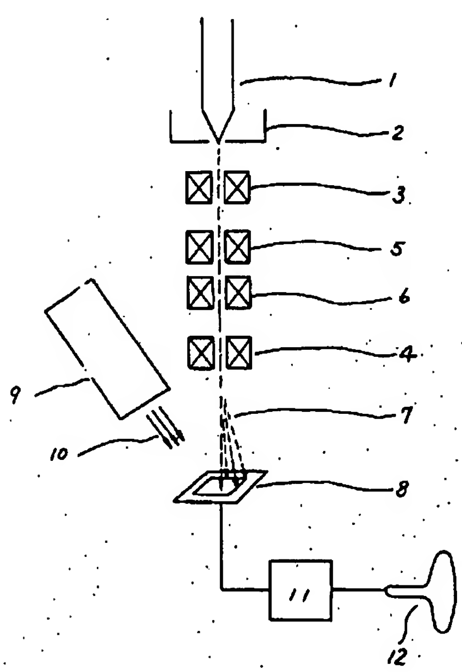
試料吸収電流像は我々の実験によれば炭素の単原子層の吸着程度でも著しく変化することを確かめており、オージエ電子分析法で用いられているはく離速度のおそいイオン銃で、イオンビームを試料表面に照射しながら試料吸収電流像を観察すれば同試料表面の表面状態の動的変化を詳細に知ることができる。

さらにオージエ電子分析において場所の選定を試料吸収電流像でおこなつているが、本発明により、イオンビームを試料表面に照射しながら場所選定をおこなうことができる。

図面の簡単な説明

図は本発明に使用した装置の構成と試料吸収電流像の記録系を示す図である。

1：一次電子線源、2：ウエーネルト電極、3 4：一次電子線収束用磁界レンズ、5、6：偏向コイル、7：一次電子線の方出を示す線、8：試料、9：イオン銃、10：イオンビームの方向を示す線、11：電気回路、12：陰極線管。



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PATENT APPLICATION

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Title of the Invention: SAMPLE ABSORPTION CURRENT IMAGE OBSERVATION METHOD

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SPECIFICATION

Title of the Invention

SAMPLE ABSORPTION CURRENT IMAGE OBSERVATION METHOD

Claims

A sample absorption current image observation device constructed from a primary electron beam column which has the function of focusing* and scanning a primary electron beam on the sample surface, an image display device which makes it possible to obtain a sample absorption current image by performing a brightness display of the charged electron current that flows into the sample on a cathode ray tube in synchronization with the scanning of the primary electron beam on the sample surface, and an ion gun which is used to strip the sample surface by means of an ion beam, this observation method being characterized by the fact that a sample absorption current image is obtained while scanning [the sample surface] with the primary electron beam focused on the sample surface, and at the same time stripping this sample surface with the ion beam.

Detailed Description of the Invention

The present invention relates to an observation method for obtaining a sample absorption current image while stripping the sample surface with an ion beam.

With the recent increase in the demand for observation of microscopic parts of solid surfaces of ICs, etc., electron microprobe surface analysis has attracted attention. For example, in the Auger electronic analysis method using an electron microprobe, a sample absorption current image is utilized as a monitor of location selection in the point analysis of the Auger electronic analysis. Furthermore, since there is a conspicuous dependence on surface conditions, there are possibilities for using [this method] as an independent surface microscopic method.

When a solid surface is irradiated with an electron beam (primary electron beam), the phenomenon of secondary electron emission occurs in which other electrons (secondary electrons) are emitted from the same solid surface. The ratio (I_2/I_1) of the electron current I_2 combining the secondary electrons and the electrons emitted from the solid surface via the process of elastic or inelastic scattering of the primary electron beam to the primary electron current I_1 is designated as δ. δ shows a conspicuous dependence on the element(s) of the solid

* Translator's note: here and elsewhere, the Japanese source text literally reads "converging," but "focusing" seems to be intended. The term "focus" is used throughout this translation where the Japanese original literally says "converge."

surface, the geometrical shape of the solid surface and surface conditions such as the crystal structure of the surface. Accordingly, by showing a brightness display of the electron current that flows into the solid sample on a cathode ray tube in synchronization with the scanning of the solid sample surface by the primary electron beam, it is possible to obtain a sample absorption current image based on differences in δ in the solid surface scanning region of the primary electron beam.

Furthermore, the ion etching method, in which atoms of a solid sample surface are knocked out by irradiating this sample surface with an ion beam so that the sample surface is stripped, is widely used in the field of solid surface technology as a means of solid surface cleaning and interface analysis, etc.

The present invention is characterized by the fact that a sample surface is irradiated with an ion beam at the same time that this sample surface is scanned with a primary electron beam, so that the surface conditions resulting from the stripping of the same sample surface can be dynamically observed by means of a sample absorption current image.

Details of the invention will be described below on the basis of an embodiment.

The figure is an explanatory diagram which shows one embodiment of the present invention; this figure shows the primary electron beam column, the construction of the ion gun and the sample absorption current image recording system. In Figure 1 [*sic*], 1 indicates a primary electron beam source, 2 indicates a Wehnelt electrode used for the focusing of the primary electron beam, 3 and 4 indicate magnetic field lenses used for the focusing of the primary electron beam, 5 indicates a deflection coil which scans the primary electron beam in one direction over the sample surface, 6 indicates a deflection coil which scans the primary electron beam over the sample surface in a direction perpendicular to the scanning direction of the coil 5, 7 shows lines that indicate the direction of the primary electron beam, 8 indicates a sample, 9 indicates an ion gun, 10 shows lines indicating the direction of the ion beam, 11 indicates an electrical circuit which converts a current ($I_1 - I_2$) that reflects the difference in δ in the charged electron current that flows into the sample into the brightness-modulated signal of a cathode ray tube, and 12 indicates a cathode ray tube.

The region on the solid sample surface that is scanned by the primary electron beam is irradiated by a direct-current ion beam generated by the ion gun 9, so that the same sample surface is stripped. Accordingly, the charged electron current that flows into the same sample is the sum of electron currents ($I_1 - I_2$) that reflect the difference in δ in the scanning region of the primary electron beam and constant ion current. A sample absorption current image can be

obtained by cutting the direct-current component of the charged electron current that flows into the sample and converting the fluctuating component into a brightness-modulated signal of the cathode ray tube 12 (in synchronization with the scanning of the solid surface by the primary electron beam) by means of the electrical circuit 11. If the diameter of the ion beam is set smaller than the primary electron beam scanning region in a sample absorption current image obtained under the same conditions, the surface conditions in portions where stripping has progressed and portions where stripping has not progressed can be dynamically observed. Conversely, if the diameter of the ion beam is set sufficiently larger than the primary electron beam scanning region, the surface conditions at a fixed depth from the solid surface can be dynamically observed.

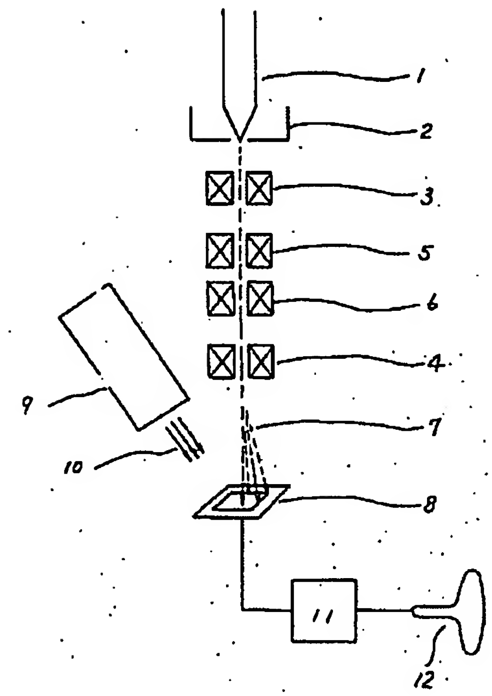
It has been confirmed by experiments conducted by the inventors that the sample absorption current image also varies conspicuously with the degree of adsorption of a monatomic layer of carbon, so that if such a sample absorption current image is observed while the sample surface is irradiated with an ion beam by means of an ion gun with a slow stripping speed [of the type] used in the Auger electronic analysis method, dynamic changes in the surface conditions of the same sample surface can be ascertained in detail.

Furthermore, in Auger electronic analysis, the selection of locations is performed using a sample absorption current image; in the present invention, the selection of locations can be performed while irradiating the sample surface with an ion beam.

Brief Description of the Drawings

The figure is a diagram which shows the construction of the apparatus used in the present invention, and the recording system [used] for the sample absorption current image.

1: Primary electron beam source; 2: Wehnelt electrode; 3, 4: Magnetic field lenses used for the focusing of the primary electron beam; 5, 6: Deflection coils; 7: Lines indicating the emission of the primary electron beam; 8: Sample; 9: Ion gun; 10: Lines indicating the direction of the ion beam; 11: Electrical circuit; 12: Cathode ray tube.



List of Appended Documents

(1) Specification: 1 copy
(2) Drawings: 1 copy
(3) Power of Attorney: 1 copy
(4) Duplicate of Patent Application: 1 copy

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